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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : D21D 1/38

A1

(11) International Publication Number: WO 86/ 06427

(43) International Publication Date: 6 November 1986 (06.11.86)

(21) International Application Number: PCT/US85/02451

(22) International Filing Date: 9 December 1985 (09.12.85)

(31) Priority Application Number: 726,966

(32) Priority Date: 29 April 1985 (29.04.85)

(33) Priority Country: US

(60) Parent Application or Grant
(63) Related by Continuation
US 726,966 (CON)
Filed on 29 April 1985 (29.04.85)

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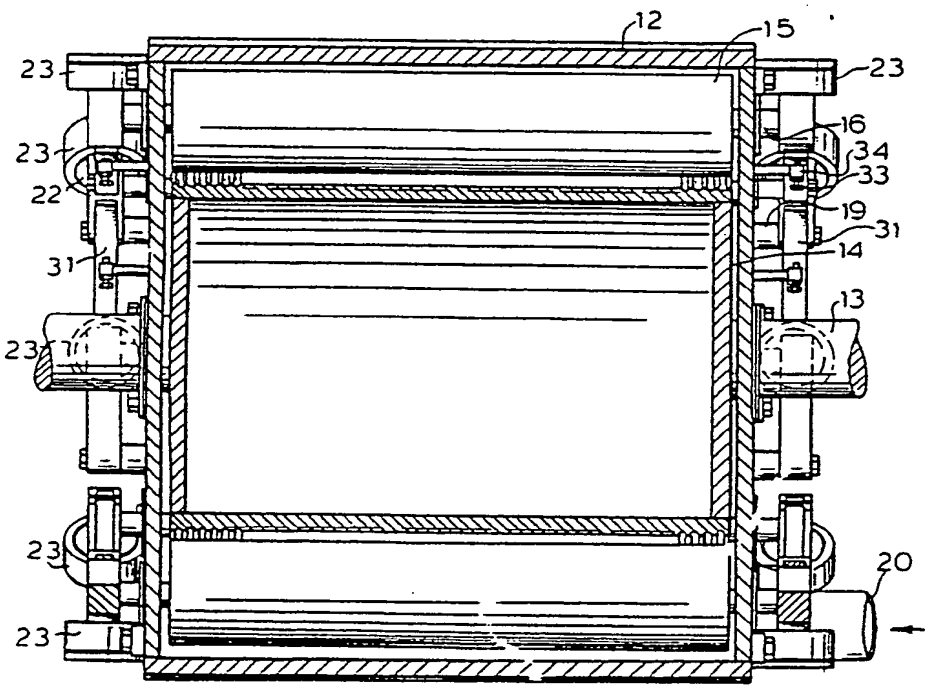
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BG, BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.

(54) Title: METHOD AND APPARATUS FOR TREATING PULP



(57) Abstract

A method and apparatus for treating pulp prior to being made into paper, which treatment is known as beating or refining. The method comprises feeding a slurry of the pulp to the narrow nips of grooved rolls (14, 15) at which the slurry of pulp is partially dewatered. Then, almost simultaneously, fragments of the pulp are subjected to a predetermined heavy pressure, then dispersed before being subjected to the same sequence until treated to the desired degree.

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METHOD AND APPARATUS FOR TREATING PULP

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

Before pulp is formed into paper, it is almost invariably subjected to mechanical treatment in order to shorten, abrade, and internally fibrillate or bruise the structure of the fibers in the desired proportion and degree. The present method of accomplishing this is to make a slurry of the pulp with a concentration (consistency) of 3% to 5% and crush and rub the mixture between disks fitted with narrow metal bars disposed nearly radially. The relative speed of the bars is usually from 3,000 to 6,000 feet per minute and the pressure between the faces of the bars may be as high as 1,000 psi. Consequently, the operation consumes a very large amount of energy for the resulting disruption of the fibrous structure. It is well recognized that, considering the results, the present method mechanically is a most inefficient operation.

An obvious approach to save energy which has, no doubt, been tried, is to crush a layer of wet fibers between smooth rolls. However, it is not possible to feed any practical amount of wet fibers through such a nip because water is squeezed from the pulp before it reaches the nip and the expressed water prevents the roll surface from grasping the pulp. Roughening the surfaces is no solution because the roughness would not improve adhesion much because the expressed water would tend to push and float the fibers away. Furthermore, the roughnesses would cut the fibers unduly even if satisfactory feeding were possible.

It should be mentioned that with common barred machines, fiber clots are formed on the rapidly moving edges of the bars,

which are further dewatered on the edges of the opposing bars when they come into contact. For effective treatment, it is necessary that the clots of pulp be dewatered to about 50% dry before mechanical treatment.

Fifty years ago, I designed a laboratory apparatus constructed to beat a small batch of about three ounces of pulp prior to making it into test sheets of paper so as to evaluate its properties. The apparatus comprised three heavy rollers with 9 milimeter wide rims having 3 milimeter wide central grooves, the rollers restrained by gearing to rotate within a frame around a smooth, flat circular track around the bottom of a v-shaped annular trough. It, and other beating devices hkve been described in detail by me in my textbook Pulp Technology And Treatment For Paper, pages 331 to 333 published by Miller Freeman in San Francisco in 1978, said disclosure being incoeporated herein by reference.

Although the described laboratory apparatus was successful and has since been adopted as one of four instruments to carry out one of the official test methods of the Technical Association of the Pulp and Paper Industry (T225 OS 75), its principle of operation was not until recently fully understood; nor was it envisaged how the tiny laboratory batch apparatus could be modified and transformed into a simple, large, commercial machine having a continuous and substantial output of several tons an hour as is now described in the present invention.

It is an object of the invention to provide a novel method and means for refining paper pulp with the minimum amount of energy.

It is another object to provide a simple means for controlling the intensity of treatment of the pulp.

It is still another object to provide means for emphasizing one or the other of the three basic actions of refining, namely, shortening, abrading, and crushing of the fibers.

SUMMARY OF THE INVENTION

The present invention relates to an apparatus and method for treating fibrous pulp prior to converting the pulp into paper by mixing the pulp with enough water to form a slurry. The apparatus includes a vessel having a drum having a central axis. The drum has narrow, closely-spaced circumferential grooves around the surface thereof. A plurality of rotatable rolls is disposed parallel to the axis of the drum and spaced around the drum. A device for flexibly pressing the rolls against the drum with a predetermined force and a device for filling the vessel with a slurry of paper pulp and motive means for causing rotation of the drum and the rolls.

More specifically, a rotating shaft with arms is adapted to remove any pulp that may have been compressed into the grooves, the shaft being located in the outgoing area between the drum and each roll. The shaft serves to integrate any compressed clots of fibers issuing from the nip. Furthermore, the apparatus includes an inlet for a slurry of pulp on one side and an outlet on the other side of the vessel whereby the pulp may be passed continuously through the vessel while being circulated around and between the drum and the rolls.

Also, the apparatus includes grooves in the rolls located so as to mesh between adjacent projections in the drum with the grooves being deeper than the height of the projections so as to permit expressed water to pass through the nip.

In a specific embodiment of the present invention, the drum has a plain surface and the rolls are grooved. A device is located at the exit of the nip to dislodge any pulp embedded in the grooves and to disperse any clots of the dislodged pulp before entering a following nip. One of the rotating members has a cylindrical surface covered with multiple small projections whose tips bear against the adjoining member and in which the small projections are located in circumferential rows and a device for continually dislodging any pulp embedded in the rows.

The apparatus includes a vessel having opposed rolls therein pressed together with a predetermined force to form a nip therebetween. A device feeds a slurry of pulp and water to the vessel and the nip between the rolls has a substantial number of compacting portions along the roll length intermittent along the length whereby water is expressed from the pulp. The water is expressed by the compacting portions with intermittent near contacting portions of the nip where the slurry is free to pass therethrough between the intermittent non-contacting portions of the pulp that have been partially dewatered.

The method of treating pulp fibers prior to making them into paper comprises the steps of mixing the fibers with sufficient water to form a slurry, directing a continuous stream of the slurry to a series of individual narrow nips located between a pair of revolving rolls. The width of the nips is less than that which would cause the slurry carrying a major portion of the ribers to enter the spaces between the sides of the nips as the rolls revolve. The revolving rolls are pressed together with a predetermined force adequate to provide the desired effect on the fibers from the slurry that passes between the nips.

More specifically, the method includes the use of narrow nips having contacts thereon whose width is no greater than 9 milimeters and the spacing between the contacts is insufficient to cause most of the slurry presented to them to be pushed to the opening between the contacts. Furthermore, the method includes continuously, mechanically dispersing clots of pulp that are compressed in the nips.

The invention also includes a method which involves passing a continuous stream of the slurry between a pair of rolls, at least one of which is driven. The rolls between them define a series of narrow nips having narrow spaces therebetween. The nip widths are such that the fibers are grasped and dewatered before being crushed by the rolls, the water flowing through the spaces between the nips, the spacing being no more than 9 milimeters. More specifically, the widths are less than 3 times the average length of the fibers in the slurry.

These and some of the other objects and advantages of the invention will hereinafter become apparent.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows somewhat schematically a front view partially in section of an apparatus embodying the invention through 1-1;

Figure 2 shows a side view partially in section taken through 2-2 of figure 1 of the apparatus;

Figure 3 shows a front section taken through 3-3 of figure 4 showing a means of applying pressure to the rolls;

Figure 4 shows a side section taken through 4-4 of figure 3;

Figure 5 shows a rotating toothed shaft adapted to keep clean the circumferential grooves on a roll;

Figure 6 is an end view taken through 6-6 of figure 5;

Figure 7 shows a side view of a portion of one form of nip between the grooved center drum and a smooth roll;

Figure 8 shows the side view of another form of the nip between a smooth roll and the center drum with circumferential and longitudinal grooves;

Figure 9 shows a side view of a portion of another form of nip between the grooved center drum and a grooved outer roll;

Figure 10 shows the front view of a portion of the center drum and a roll both longitudinally and circumferentially grooved; and

Figure 11 is a side view of part of figure 10 through X1-X1.

DETAILED DESCRIPTION

Basically, the method of treating pulp fibers in accordance with the present invention involves mixing the fibers with sufficient water to form a slurry, directing a continuous stream of slurry through a series of narrow nips located between a pair of revolving rolls, the widths of the nips being less than that which would cause the slurry conveying a major portion of the fibers to enter the spaces between the sides of the nip as the rolls revolve, and pressing the revolving rolls together with a predetermined force adequate to provide the desired effect on the fibers from the slurry that passes between the nips. The narrow nips have contact thereon whose widths do not exceed significantly the lengths of the longest

fibers in the slurry, so the contacts generally have widths not exceeding about 9 milimeters and preferably are 3 milimeters or less.

By so adjusting the relationship between the row of intermittent contacting widths in the nips, they grasp and dewater the fibers before crushing them, allowing the water to flow through the spaces between the compacting widths. This action will not happen if the contacts are much wider than the longest fibers in the slurry because in that case, the individual nips would push the slurry sideways to the openings and not allow them to grasp any but a tiny proportion of the fibers.

In the preferred embodiment of the invention, there are a large number of contacting elements along the length of the roll. Each element preferably has a width of less than 3 times the average length of the fibers in the pulp with channels between the elements of sufficient size to permit passage of the water squeezed from the pulp by adjacent elements. Thus, the spacing between the contacts is insufficient to cause most of the slurry presented to them to be pushed to the openings between the contacts.

Another feature of the present invention involves continuously mechanically dispersing clots of pulp that have compressed in the nips.

In the drawings 12 indicates the outer cylindrical casing of one form of the apparatus of the invention. Mounted on a shaft 13 driven by a motor (not shown) is a circumferentially grooved drum 14. Spaced around the drum are a number of usually plain rolls 15, each of which has a shaft 16, the ends of which pass through holes in the sides of the casing 12 and

rotate on bearings 17 which are housed at the ends of lever arms 18 which are pivoted on pins 19 affixed to both sides of the casing. Normally, only the grooved drum 14 is driven, the rolls 15 being rotated by friction. However, all the rolls 15 may be geared together and driven separately. In this case, with some paper stocks, it may be desirable to subject the fibers to additional rubbing by arranging for a differential peripheral speed between the drum 14 and the rolls 15.

The casing 12 has an inlet 20 and an outlet 21 (shown schematically by arrowed lines) for the pulp slurry which at the desired consistency is pumped through the apparatus at the desired rate depending on the extent of treatment required.

The rolls 15 from both sides are pressed against the driven drum 14 by a circular piston 22, figure 3, sliding in a casting 23 which piston is part of the arm 18 and which is activated by fluid pressure supplied through inlets 24 to a rubber diaphragm 25, all of which inlets may be connected to a common fluid pressure source. If the apparatus is not operated in a vertical but in a horizontal position, the arm of each roll is supplied, for example, with a leaf spring 31 held at one end by a stud 32 affixed to one side of the casing 12 and by means of screw 33 turning in pillar 34, caused to balance the weight of rolls 15 if the rolls are situated on the upper part of the casing or if the rolls are on the lower part, to apply upward pressure to arm 18 to support the weight of the rolls. The springs will not be needed for the two rolls in the middle. It will be observed that the movement of the rolls 15 needs to be only very small, enough to provide some flexibility if a large lump of pulp goes through the nip.

Referring to figures 5 and 6 located adjacent to the outgoing sides of each of the nips between all the rolls 15, adjacent the drum 14 is a milled shaft 26 driven by a high speed motor (not shown). The shaft 26 carries spike wheels 27 which have teeth 27a milled in the periphery so that the tips sweep through the grooves on drum 14 and keep them clear in case any pulp should plug their grooves. A simple means of preventing leakage through the sides of casing 12 is to have the shaft 26 pass through an opening in a seal 28 which is held in place by a ring 28a held by bolts 29a against the housing end 29. The seal is made of rubber or suitable sealing material constructed essentially as illustrated for sealing the rotary shaft. A similar construction for shaft 16 is shown in figure 4 where the seal is shown simplified for purposes of illustration only as a rubber disk 28 with a shaft opening therethrough and it will be understood that various forms of seals may be employed. The milled shaft 26, figures 5 and 6 and teeth 27a have the additional and desirable function of dispersing clots of pulp that were loosened after being compressed in the nips.

Figure 7 shows one type of contact between the rolls 15 and the drum 14 which by adjusting the pressure to about 30 pounds per land width of about 1/8 inch and the concentration (consistency) of the pulp to about 3% gives results similar to that of barred apparatus with respect to shortening abrasion and crushing, all of which occur to some degree.

It is contemplated that a pattern illustrated in figure 8 will enhance the shortening effect if this is desired, and that shown in figures 9 and 10 will enhance the abrading effect.

The patterns are not to be presumed restricted to those shown but may assume a number of different forms depending on the type of pulp, the type of paper desired, the consistency of the pulp, the applied pressure between the rolls, and the throughput.

The means of keeping teeth in the rolls 14 and 15 clean and the pulp dispersed in the pattern shown in figure 10 and 11 may take the same form as shown in figures 5 and 6, operating in circumferential grooves spaced around the rolls, whereas that shown in figure 9 may require the shafts to be situated such that the teeth are applied to each roll.

It will be obvious that many modifications to the apparatus may be made without departing from the spirit of the invention which is mainly that of providing a very flexible treatment of pulp for paper with a minimum of energy as compared to existing machines.

What is claimed is:

1. A machine for treating pulp prior to its being made into paper comprising, in combination:

a vessel having a drum (14) having a central axis, narrow, closely-spaced circumferential grooves around its surface;

a plurality of rotatable rolls (15) parallel to said axis spaced around the drum;

means (22) for flexibly pressing the rolls (15) against the drum (14) with a predetermined force;

means (20) for filling the vessel with a slurry of paper pulp; and

means for causing rotation of the drum and the rolls.

2. A machine constructed in accordance with claim 1 in which a rotating shaft (26) with arms is adapted to remove any pulp that may be compressed into said grooves;

said shaft (26) being located in the outgoing area between the drum (14) and each roll (15) and serving to disintegrate any compressed clots of fibers issuing from said grooves.

3. A machine constructed in accordance with claim 1, having an inlet (20) for a slurry of pulp on one side and an outlet (21) on the other side of the vessel whereby;

the pulp may be passed continuously through said vessel while being circulated around and between said drum (14) and said rolls (15).

4. A machine constructed in accordance with claim 1, including;

grooves in the rolls (15) located so as to mesh between adjacent projections in said drum with said grooves

being deeper than the height of the projections so as to permit expressed water to pass through the nips defined by said drum and said rolls.

5. A machine constructed in accordance with claim 1, wherein;

said drum (14) has a plain surface and said rolls (15) are grooved.

6. A machine constructed in accordance with claim 5, with means (26) located at the exit of a nip to dislodge any pulp embedded in the grooves and to disperse any clots of the dislodged pulp before entering a following nip.

7. A machine in accordance with claim 7 in which the small projections are located in circumferential rows and means continually to dislodge any pulp embedded in said rows.

9. A machine for treating fibrous pulp prior to converting it into paper handlign pulp mixed with enough water to form a slurry comprising:

a vessel having opposed rolls (14,15) therein pressed together with a predetermined force to form a nip therebetween;

means (20) feeding a slurry of pulp and water to the vessel;

said nip between the rolls having a substantial number of contacting portions along the roll length intermittent along the length whereby water is expressed from the pulp by the contacting portions and having intermittent near contacting portions of the nip where the slurry is free to pass therethrough between the intermittent non-contacting portions while the contacting portions of the nip crush and

rub the portions of the pulp that have been partially dewatered.

10. The method of treating pulp fibers prior to making them into paper which comprises the steps of:

mixing said fibers with sufficient water to form a slurry,

directing a continuous stream of said slurry to a series of individual narrow nips located between a pair of revolving rolls (14,15), the widths of said rolls being less than that which would cause the slurry carrying a major portion of the fibers to enter the spaces between the sides of the nips as the rolls revolve; and

pressing the revolving rolls together with a predetermined force adequate to provide the desired effect on the fibers from the slurry that passes between said nips.

11. A method according to claim 10, wherein said narrow nips have contacts thereon whose widths are not greater than 9 millimeters.

12. A method according to claim 11 in which the spacing between said contacts is insufficient to cause most of the slurry presented to them to be pushed to the openings between the contacts.

13. A method according to claim 10 which comprises continuously mechanically dispersing clots of pulp that are compressed in said nips.

14. The method of treating pulp fibers prior to making them into paper which comprises the steps of:

forming an aqueous pulp slurry from said fibers;

passing a continuous stream of said slurry between a pair of rolls (14,15) at least one of which is driven,

said rolls between them defining a series of narrow nips having narrow spaces therebetween, the nip widths being such that the fibers are grabbed and dewatered before being crushed by said rolls, the water flowing through the spaces between the nips, the spacing being no more than about 9 milimeters.

15. A method according to claim 14 wherein said widths being less than 3 times the average length of the fibers in the slurry.

FIG. 1

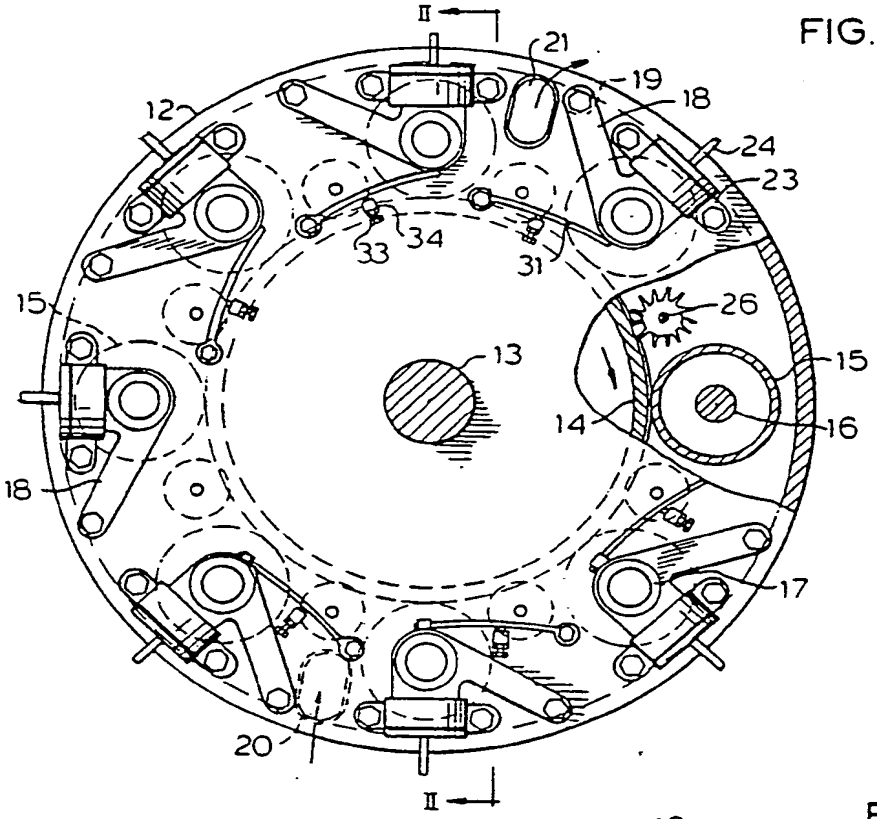

FIG. 2

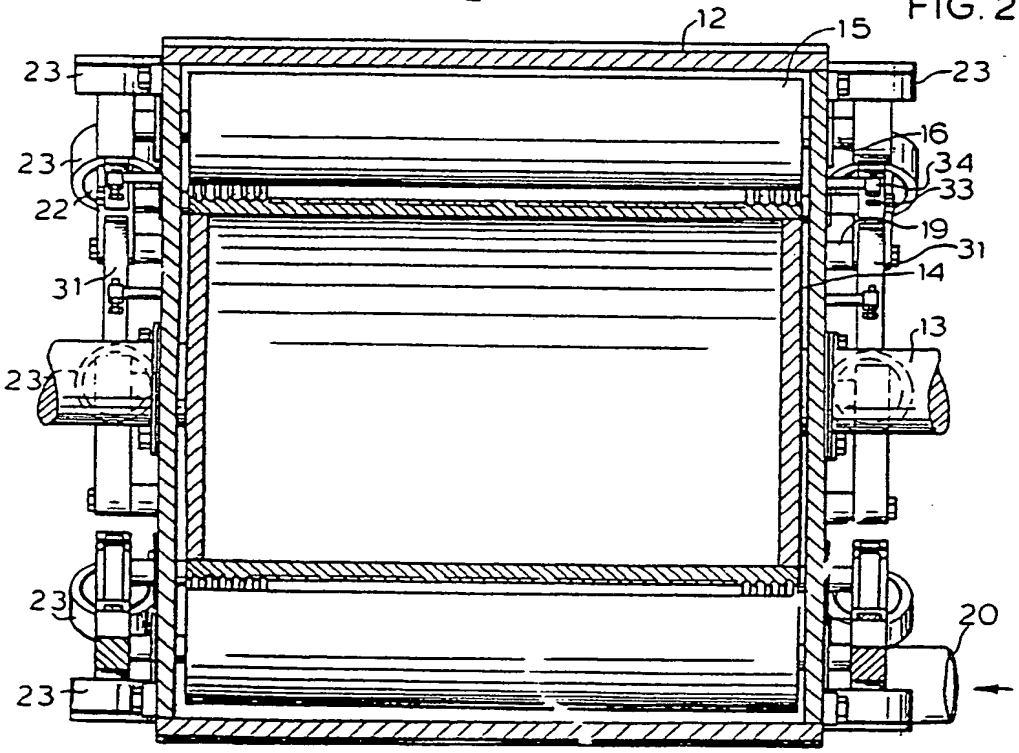

FIG. 3

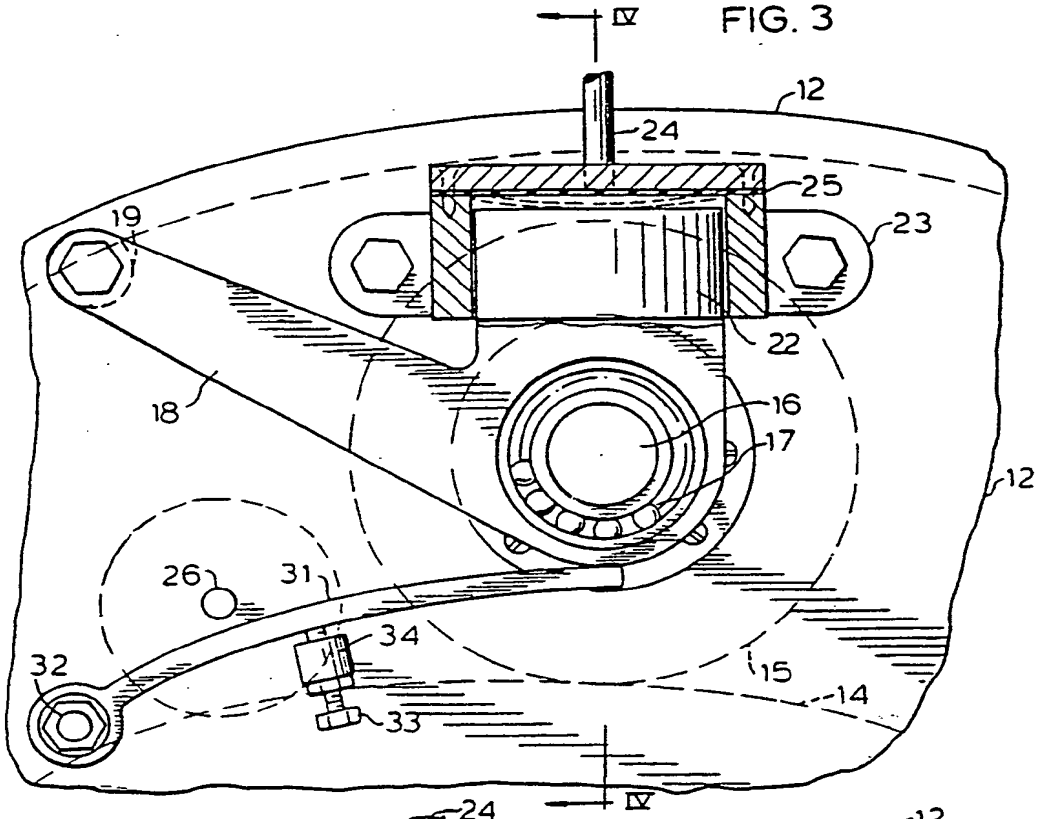
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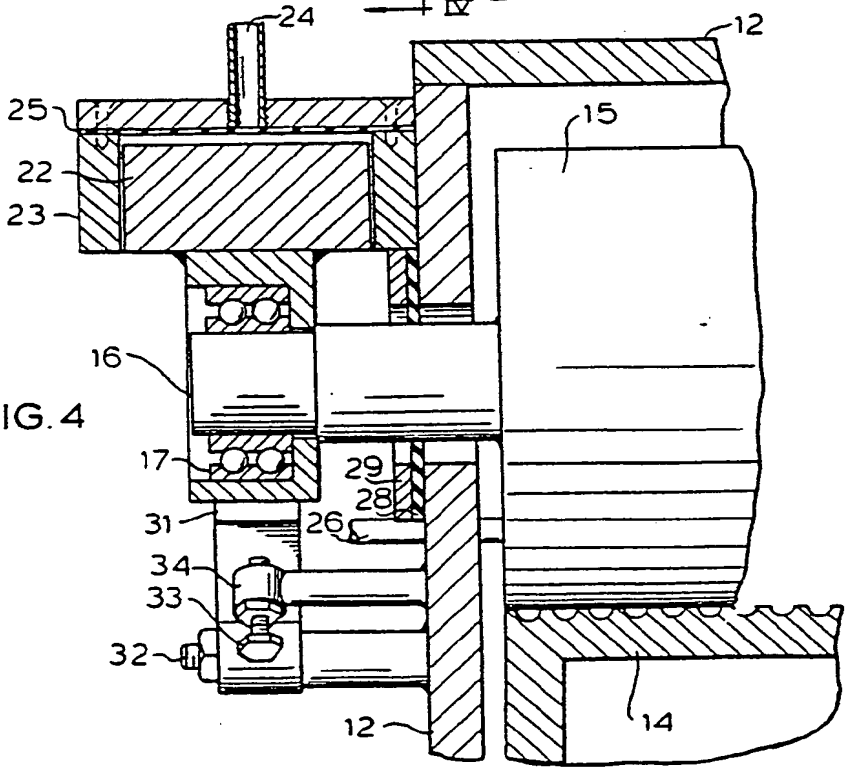
FIG. 4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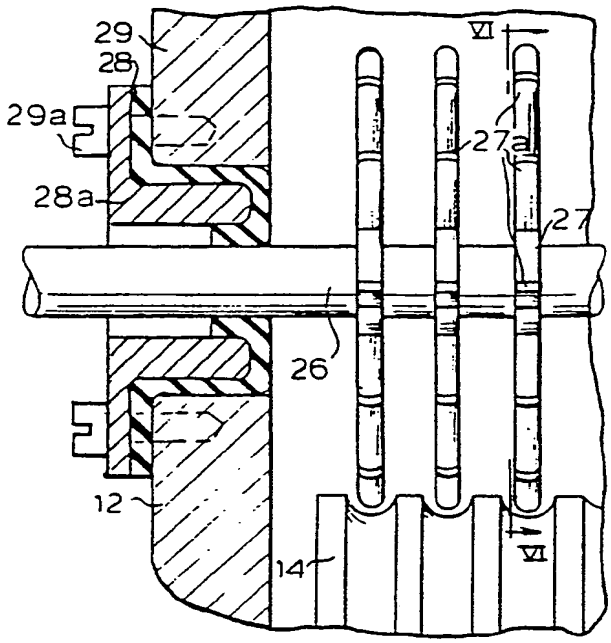


FIG. 5

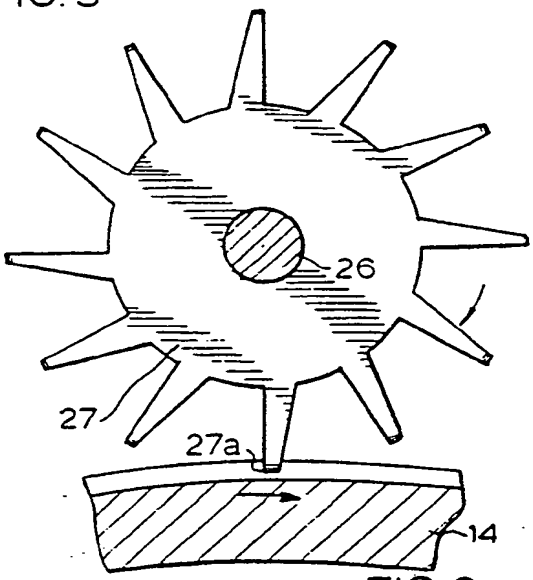


FIG. 6

FIG. 7

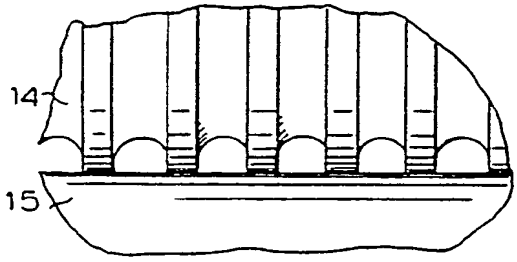


FIG. 8

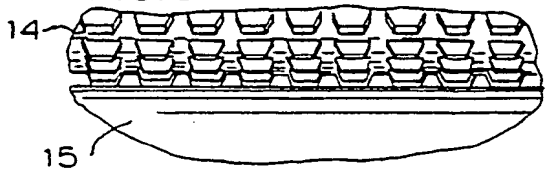
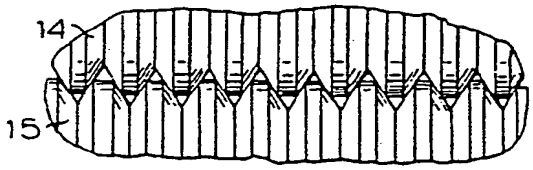


FIG. 9



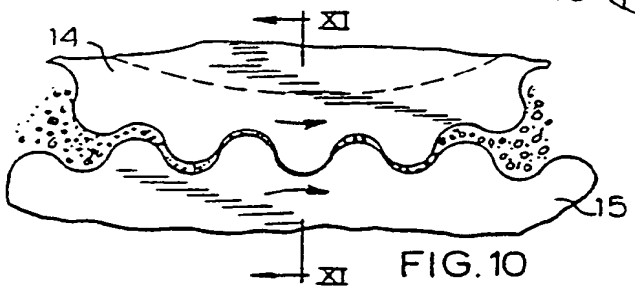


FIG. 10

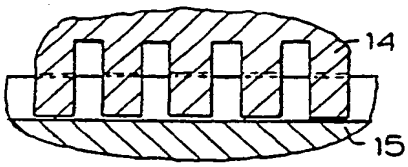


FIG. 11

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 85/02451

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: D 21 D 1/38

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	D 21 D D 21 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [9]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 2719463 (HAUG) 4 October 1955, see the whole document	1,3,5,6,9,10, 13
A		2,14
	--	
X	GB, A, 528244 (VINCENT) 25 October 1940, see the whole document	1,5,9,10
A		14
	--	
A	US, A, 2289013 (HAUG) 7 July 1942, see page 1, column 1, line 52 - page 2, column 1, line 44; figures 1,2	1,3,5,9,10, 14
	--	
A,P	EP, A, 0146515 (ERIKSSON, FOLKE) 26 June 1985	

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* Special categories of cited documents: [10]

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
4th April 1986	25 AVR. 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	M. VAN MOL

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT

INTERNATIONAL APPLICATION NO. PCT/US 85/02451 (SA 11792)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 16/04/86

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 2719463		None	
GB-A- 528244		None	
US-A- 2289013		None	
EP-A- 0146515	26/06/85	SE-A- 8306615	31/05/85
		JP-A- 60139888	24/07/85

For more details about this annex :
see Official Journal of the European Patent Office, No. 12/82